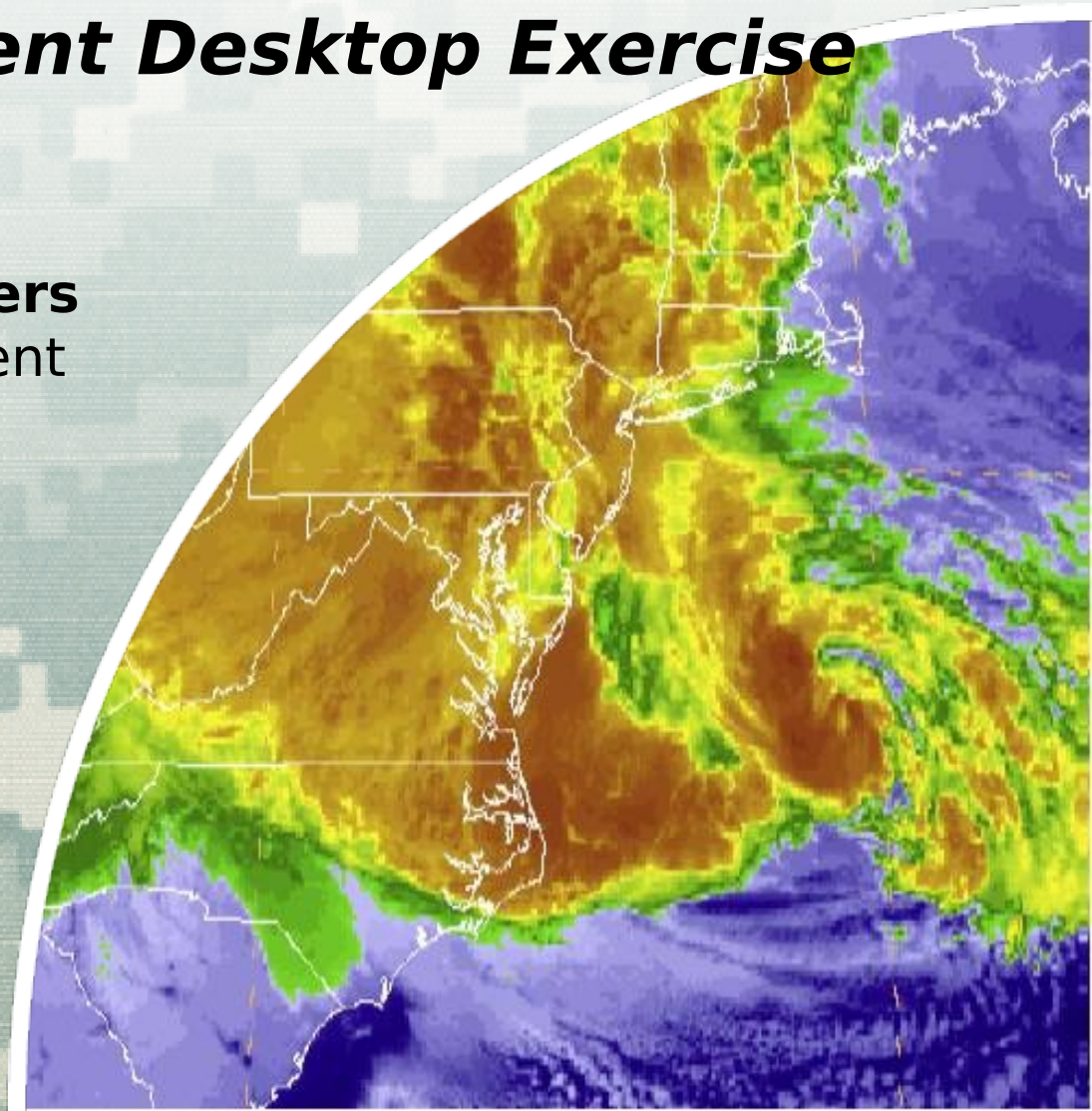
North Atlantic Coast Comprehensive Study

Exposure Assessment Desktop Exercise



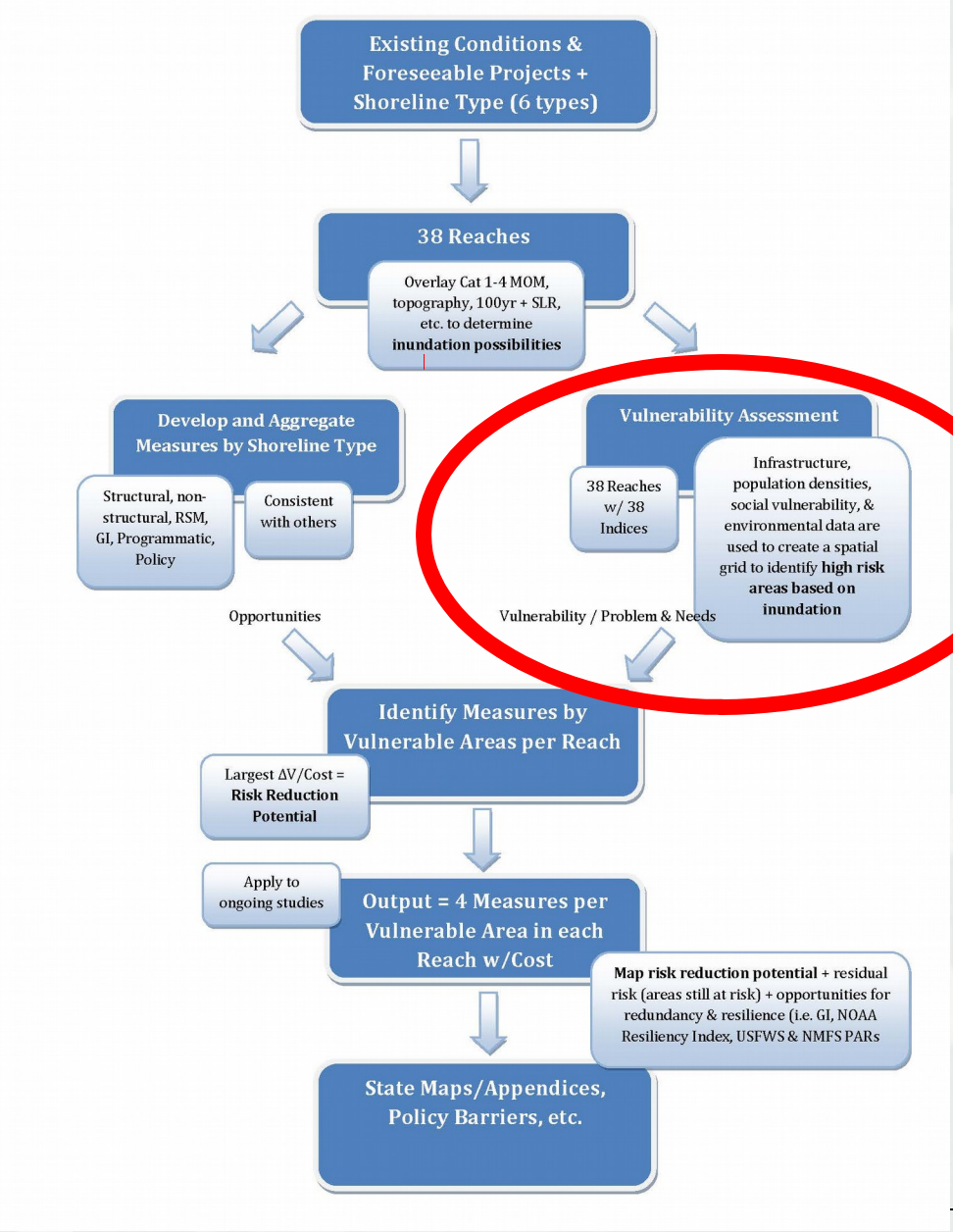
U.S. Army Corps of Engineers
Coastal Storm Risk Management
Planning Center of Expertise

25 September 2013

Working Definitions

- Resiliency – The ability to avoid, minimize, withstand, and recover from the effects of adversity, whether natural or manmade, under all circumstances of use – applies to engineering, ecological, and communities
- Redundancy – Redundancy is the duplication of critical components of a system with the intention of increasing reliability of the system, usually in the case of a backup or fail-safe
- Robustness – Robustness is the ability of a system to continue to operate correctly across a wide range of operational conditions with minimal damage, alteration or loss of functionality, and to fail gracefully outside of that range
- Risk – The risk of a coastal storm event is its probability of occurrence multiplied by the consequences. The consequences are measured in terms of life safety and property/asset damages
- Vulnerability – a function of the character and magnitude to which a system is exposed, the sensitivity of the system, and the system's adaptive capacity
  - Exposure – the nature and magnitude of the hazards that threaten the system
  - Sensitivity – the potential of system's valued functions to be affected by the changes caused by a hazard
  - Adaptation – Adaptive capacity, adaptive management, climate change adaptations

Plan Formulation and GIS Process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Consistent with others
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Largest ΔV/Cost = Risk Reduction Potential
Apply to ongoing studies
Output = 4 Measures per Vulnerable Area in each Reach w/Cost
Map risk reduction potential + residual risk (areas still at risk) + opportunities for redundancy & resilience (i.e. GI, NOAA Resiliency Index, USFWS & NMFS PARs
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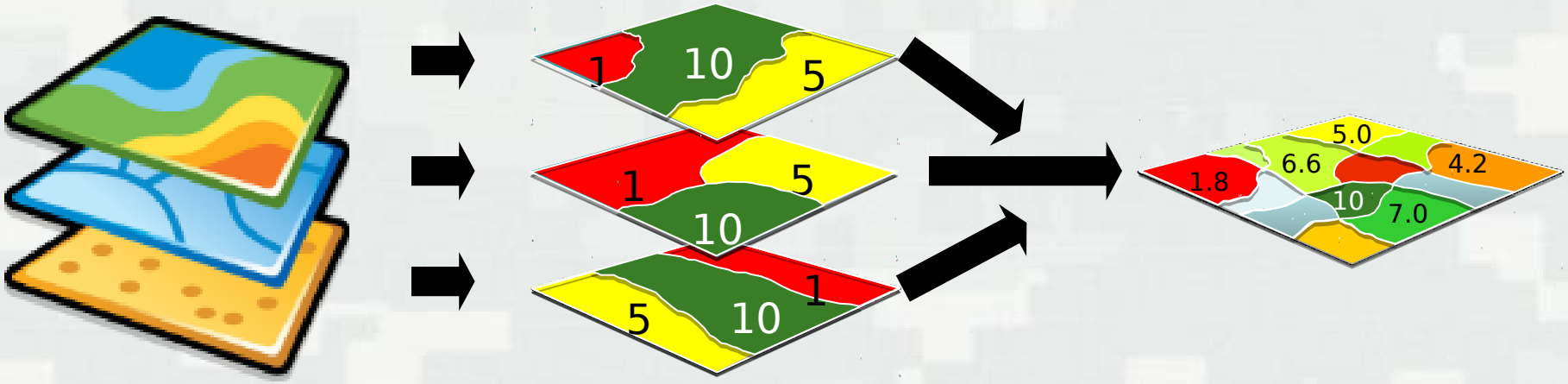
Creation Steps of the Independent Exposure Indices

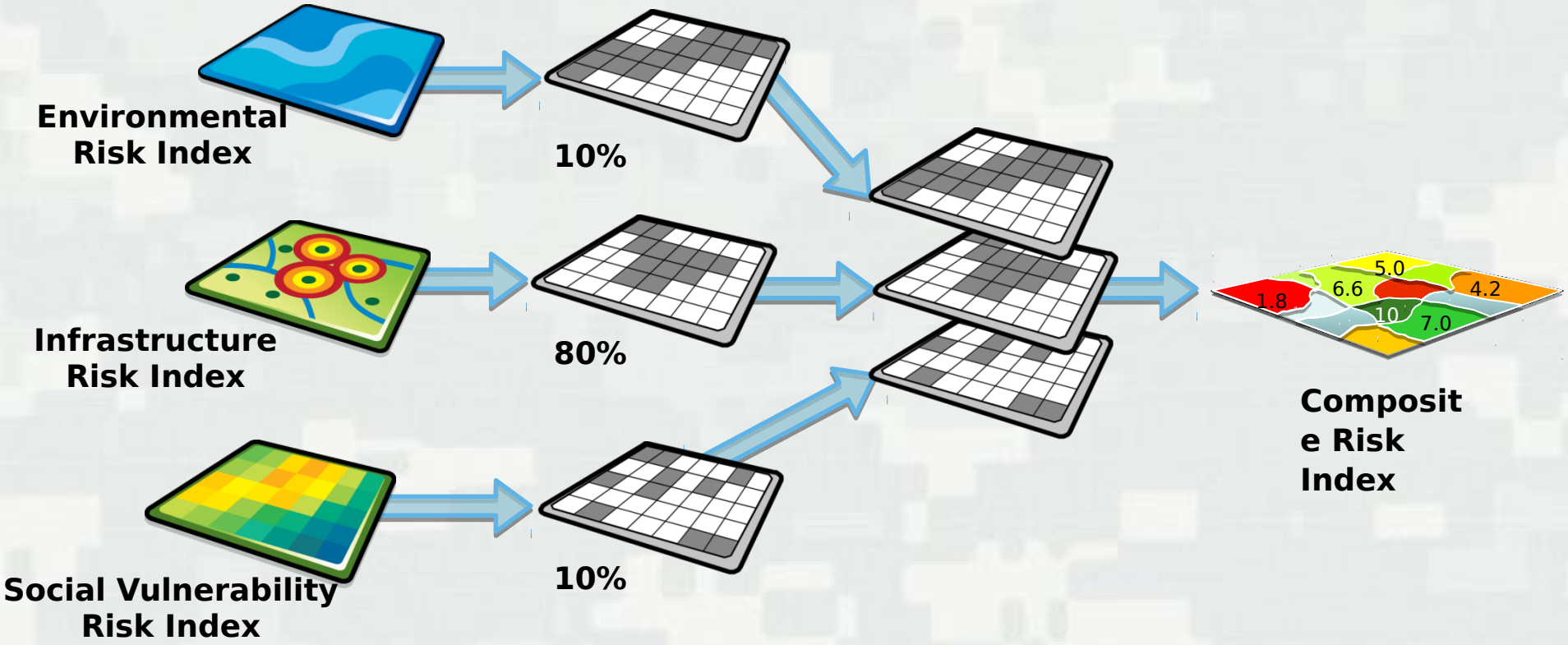


Input Data Layers

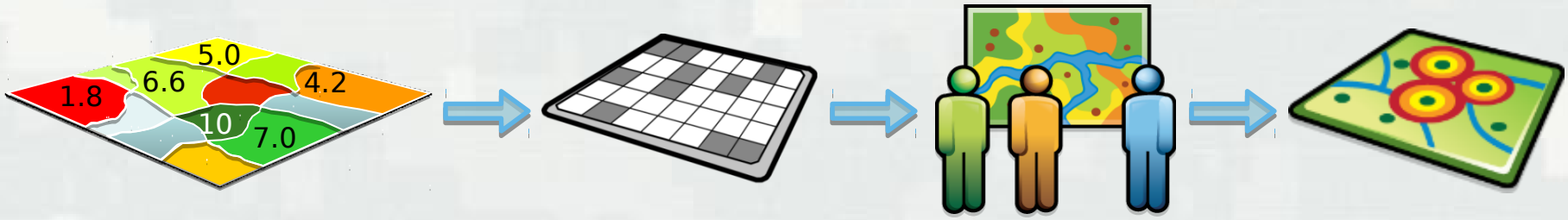
Weighted Input Data Layers

Risk Index Layer

Creation Steps of the Composite Exposure Index



Problem Areas Identification



Composite Risk Index

Apply Minimum Risk Threshold

Regional Area Expert Problem Identification Verification

(USACE, Other Federal Agencies, and State Agencies)

NACCS Problem Area Locations

Plan Formulation and GIS Process

Exposure Assessment

***Infrastructure + Population Index**

***Social Index**

-2010 Census (tract level)

-% Population 65 and over

-% Population under 5

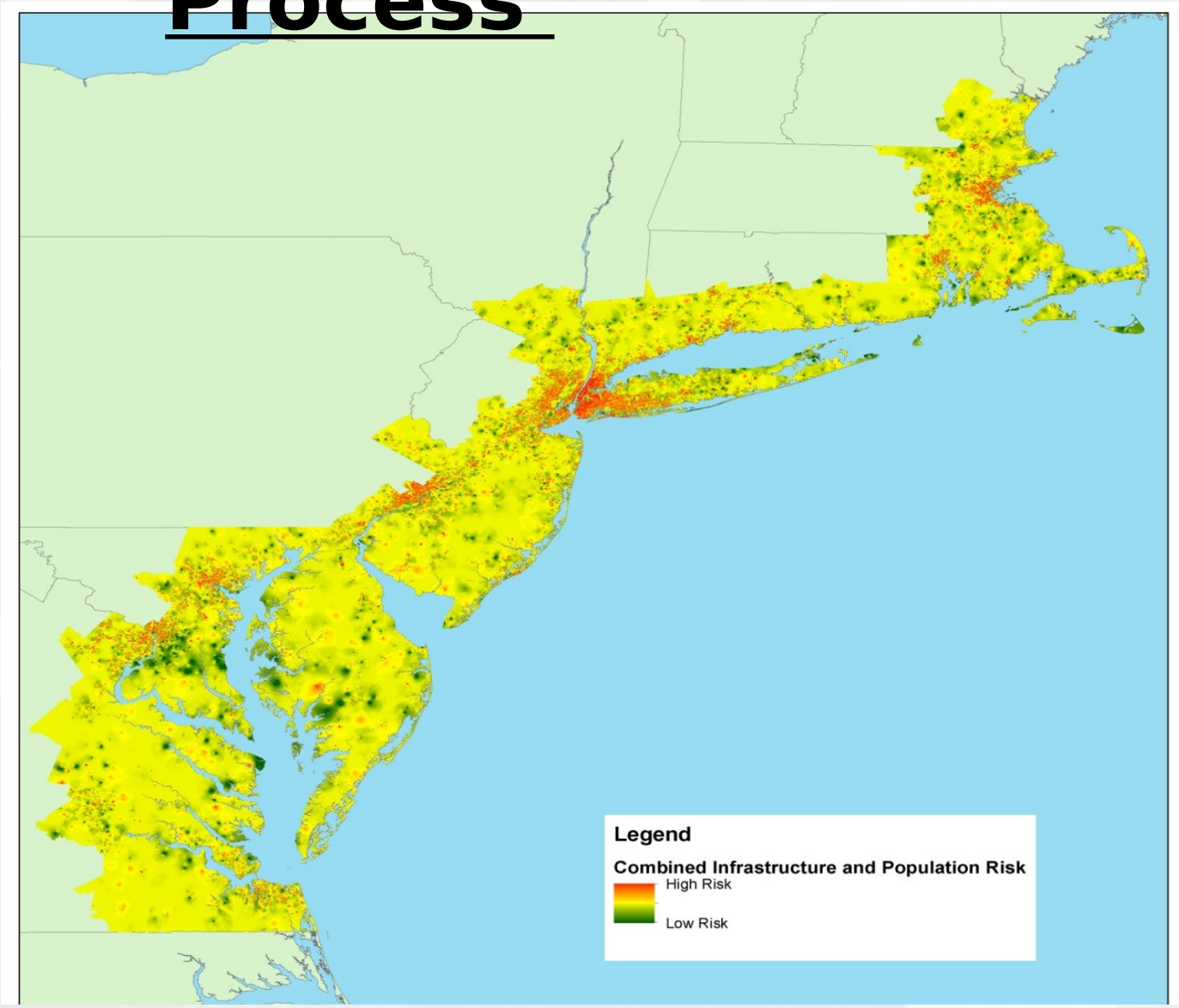
-% Population w/income below poverty

-% Population non-proficient English speakers

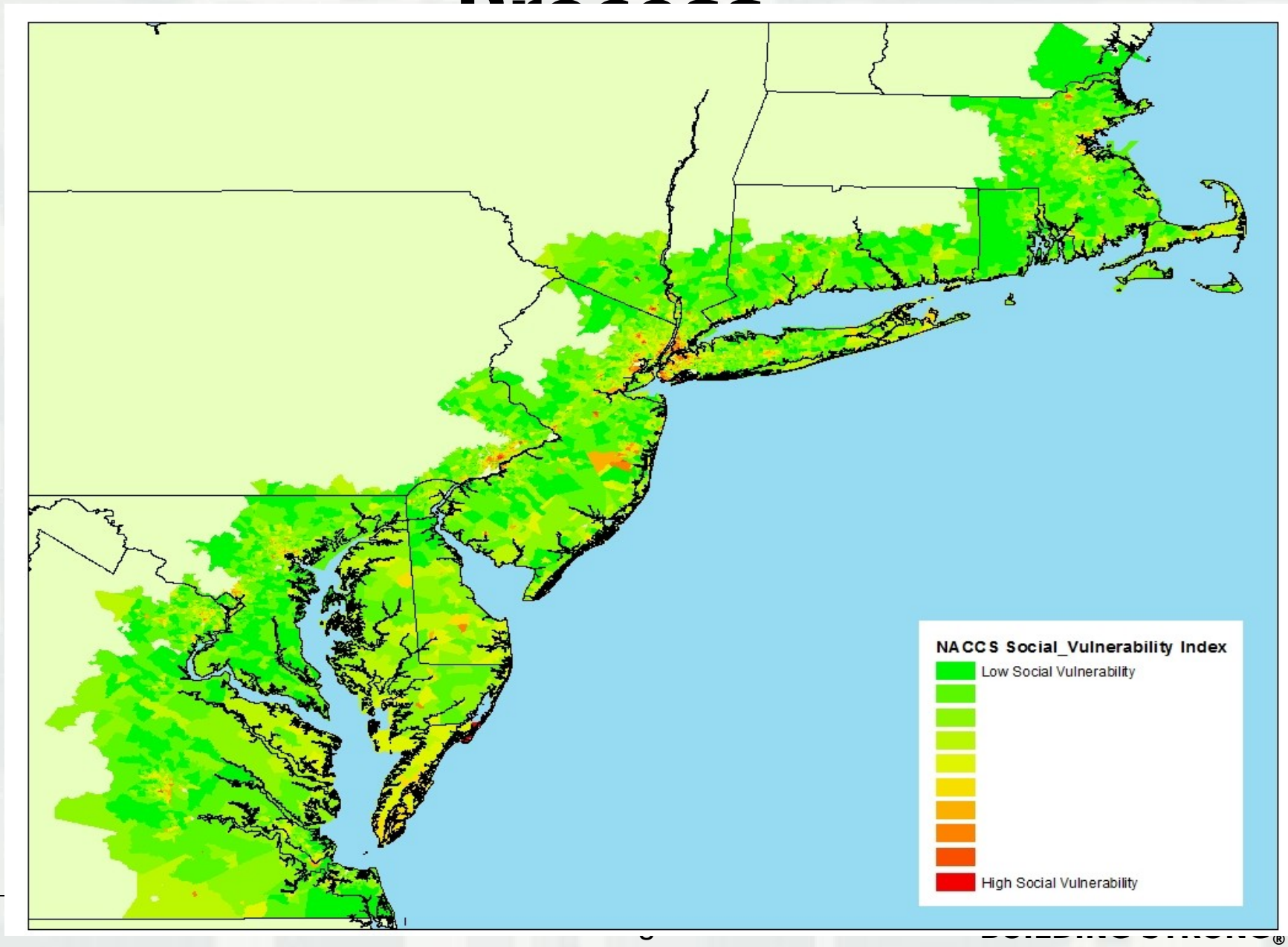
-Index of income inequality

***Environmental Index**

***Combined**



Plan Formulation and GIS Process



Sea Level Change Background

- Intergovernmental Panel on Climate Change predicts continued or accelerated global warming, which will cause continued or accelerated rise in global mean sea-level
- Climate-driven global mean sea level change (SLC) scenarios have been developed by USACE (2011) and NOAA (2012)
- These scenarios are suitable for use in assessing the future impacts of sea level change on the natural environment and human infrastructure
- The application of these SLC scenarios for the North Atlantic Coast Comprehensive Study (NACCS) is outlined in this presentation

USACE 2011: ***Sea-Level Change Considerations for Civil Works Programs***

NOAA 2012: ***Global Sea Level Rise Scenarios for the United States National Climate Assessment***

Global vs. Local Sea Level Change

- During the 20th century global mean sea level rise stabilized to approximately 1.7mm/yr (IPCC 2007)
- Local Relative Sea Level Change (RSLC) is influenced by decadal-scale climate and oceanographic patterns
- These patterns may influence sea level on a temporary (decadal or shorter) basis, but these fluctuations are NOT associated with long-term sea level change patterns
- RSLC relies on long-term water level records > 30 years to remove non-GMSL sea level fluctuations and capture local/regional land uplift and subsidence

IPCC 2007. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*

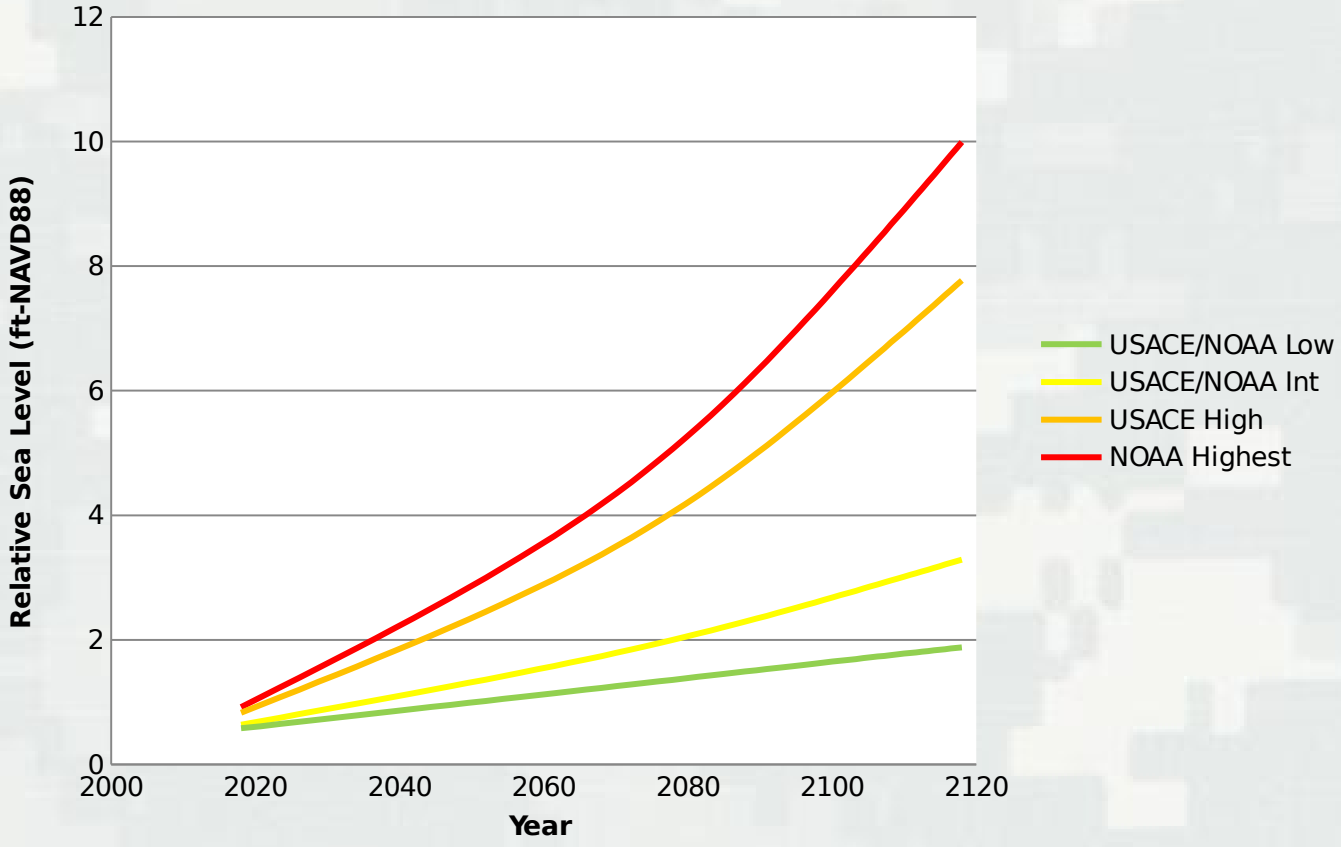
Site-Specific Future Sea Level Change

- RSLC is the sum of global mean sea level change and regional/local vertical land subsidence/uplift
- Relative sea level change (RSLC) is required to assess sea level change impacts at specific sites
- RSLC has been measured directly by NOAA long term water level gages
- 35 NOAA water level gage sites from VA to MA were evaluated for NACCS

NACCS SLR Scenarios

USACE 2011: Sea-Level Change Considerations for Civil Works Programs

NOAA 2012: Global Sea Level Rise Scenarios for the United States National Climate Assessment



Sea Level Rise Mapping

Location	Gage Number
Eastport, ME	8410140
Bar Harbor, ME	8413320
Portland, ME	8418150
Seavey Island, ME	8419870
Boston, MA	8443970
Woods Hole, MA	8447930
Nantucket Island, MA	8449130
Newport, RI	8452660
Providence, RI	8454000
New London, CT	8461490
Bridgeport, CT	8467150
Montauk, NY	8510560
Port Jefferson, NY	8514560
Kings Point, NY	8516945
The Battery, NY	8518750
Sandy Hook, NJ	8531680
Atlantic City, NJ	8534720
Cape May, NJ	8536110
Philadelphia, PA	8545240
Reedy Point, DE	8551910
Lewes, DE	8557380
Ocean City, MD	8570283
Cambridge, MD	8571892
Chesapeake City, MD	8573927
Baltimore, MD	8574680
Annapolis, MD	8575512
Solomons Island, MD	8577330
Washington, DC	8594900
Kiptopeke, VA	8632200
Colonial Beach, VA	8635150
Lewisetta, VA	8635750
Gloucester Point, VA	8637624
Sewells Point, VA	8638610
Portsmouth, VA	8638660
Chesapeake Bay Bridge Tunnel, VA	8638863

Gauge: 8571892, MD, Cambridge: 64 yrs
All values are in feet (NAVD88)

Year	USACE Low	USACE Int	USACE High	NOAA High
2018	0.4	0.46	0.65	0.74
2068	0.99	1.5	3.13	3.94
2100	1.37	2.4	5.69	7.32
2118	1.58	2.99	7.46	9.69

Gauge: 8574680, MD, Baltimore: 105 yrs
All values are in feet (NAVD88)

Year	USACE Low	USACE Int	USACE High	NOAA High
2018	0.3	0.36	0.55	0.64
2068	0.8	1.31	2.94	3.75
2100	1.11	2.15	5.44	7.07
2118	1.29	2.7	7.18	9.4

Gauge: 8594900, DC, Washington: 83 yrs
All values are in feet (NAVD88)

Year	USACE Low	USACE Int	USACE High	NOAA High
2018	0.11	0.17	0.36	0.45
2068	0.61	1.12	2.75	3.56
2100	0.93	1.96	5.25	6.89
2118	1.11	2.52	6.99	9.22

Gauge: 8575512, MD, Annapolis: 79 yrs
All values are in feet (NAVD88)

Year	USACE Low	USACE Int	USACE High	NOAA High
2018	0.33	0.39	0.58	0.68
2068	0.88	1.39	3.02	3.83
2100	1.23	2.26	5.55	7.18
2118	1.42	2.83	7.31	9.53

Gauge: 8577330, MD, Solomons Island: 70 yrs
All values are in feet (NAVD88)

Year	USACE Low	USACE Int	USACE High	NOAA High
2018	0.39	0.45	0.64	0.74
2068	0.97	1.48	3.11	3.92
2100	1.34	2.38	5.67	7.3
2118	1.55	2.96	7.44	9.66

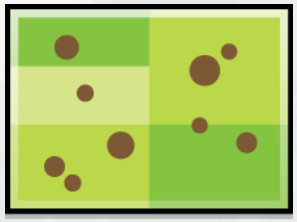
Gauge: 8570283, MD, Ocean City: <40yrs
All values are in feet (NAVD88)

Year	USACE Low	USACE Int	USACE High	NOAA High
2018	0.74	0.80	0.99	1.08
2068	1.46	1.98	3.61	4.42
2100	1.93	2.97	6.25	7.90
2118	2.19	3.60	8.08	10.32

Gauge: 8573927, MD, Chesapeake City: <40yrs
All values are in feet (NAVD88)

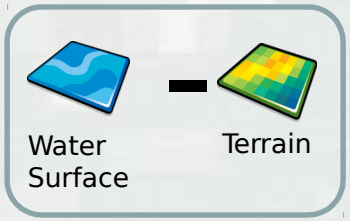
Year	USACE Low	USACE Int	USACE High	NOAA High
2018	0.30	0.36	0.55	0.64
2068	0.80	1.31	2.94	3.75
2100	1.11	2.15	5.44	7.08
2118	1.29	2.70	7.18	9.42

Sea Level Change Inundation Depth and Location Process

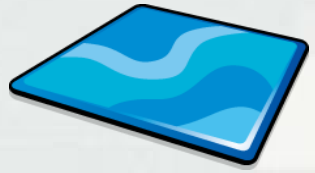


Plot NOAA Tide Station Locations

Using Sea Level Change Curves Interpolate a New Water Surface Layer

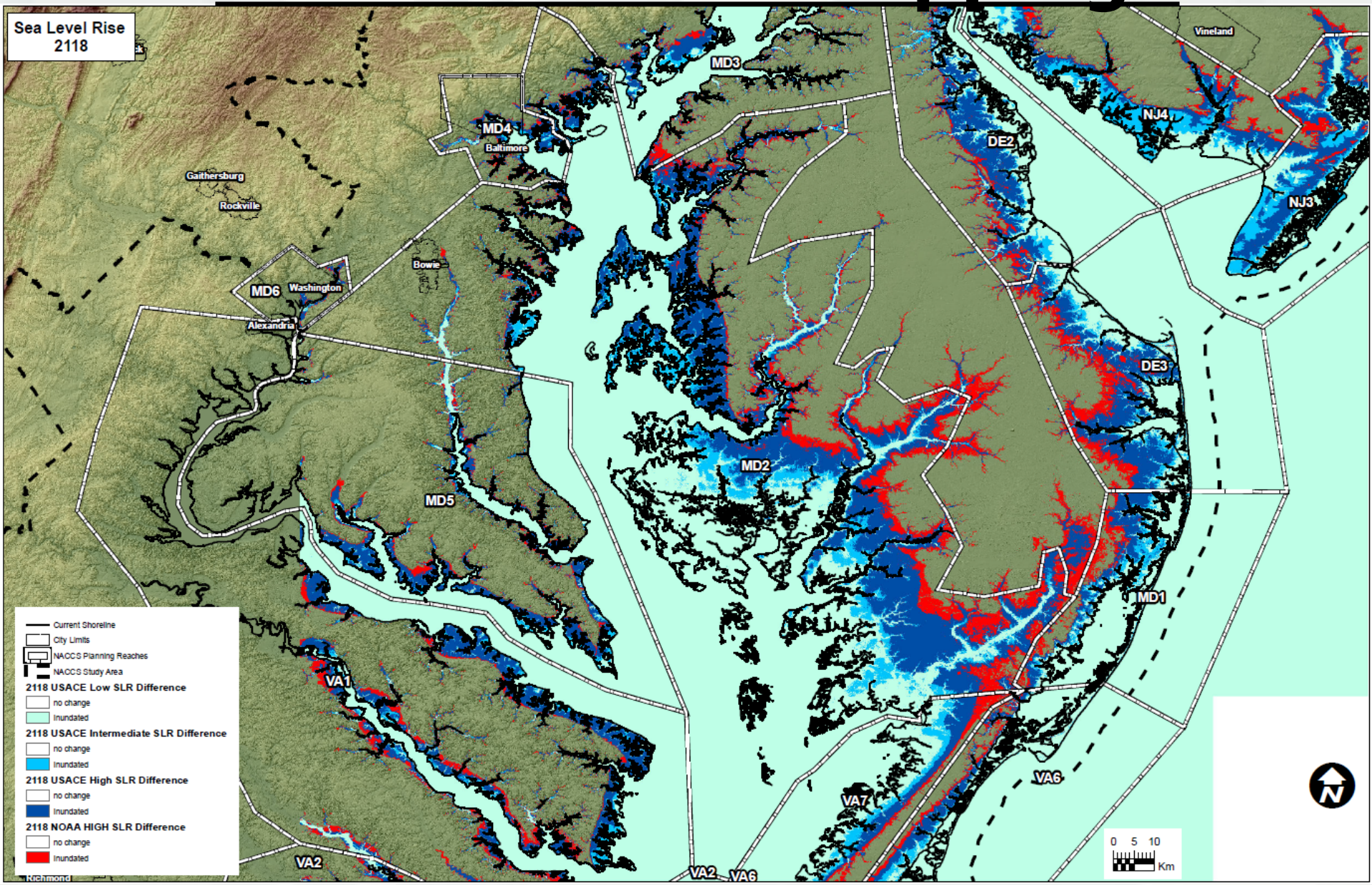


Use a Map Algebra Expression to Calculate Depth and Location of Inundated Areas



Sea Level Change Water Depths

Sea Level Rise Mapping



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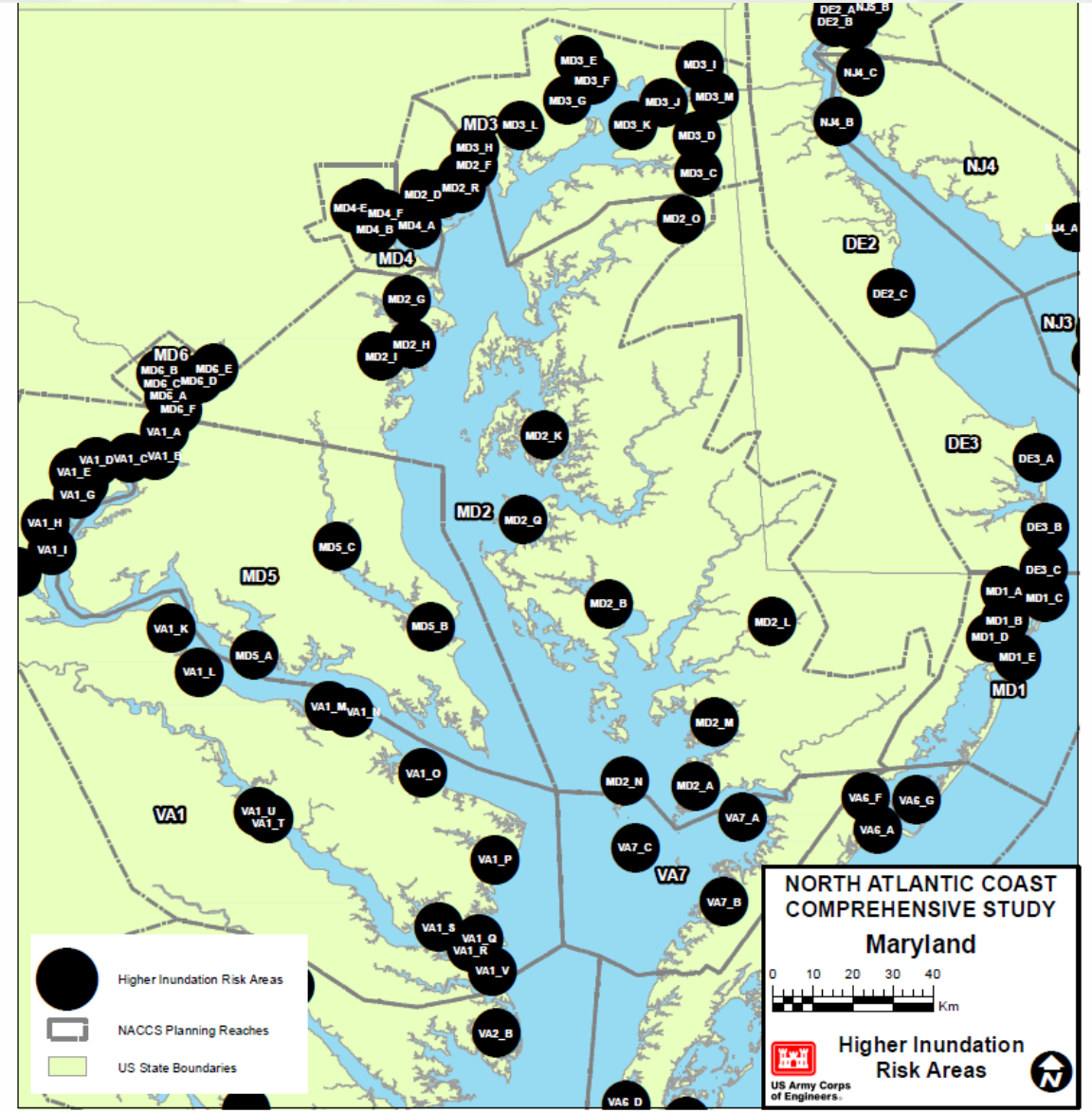

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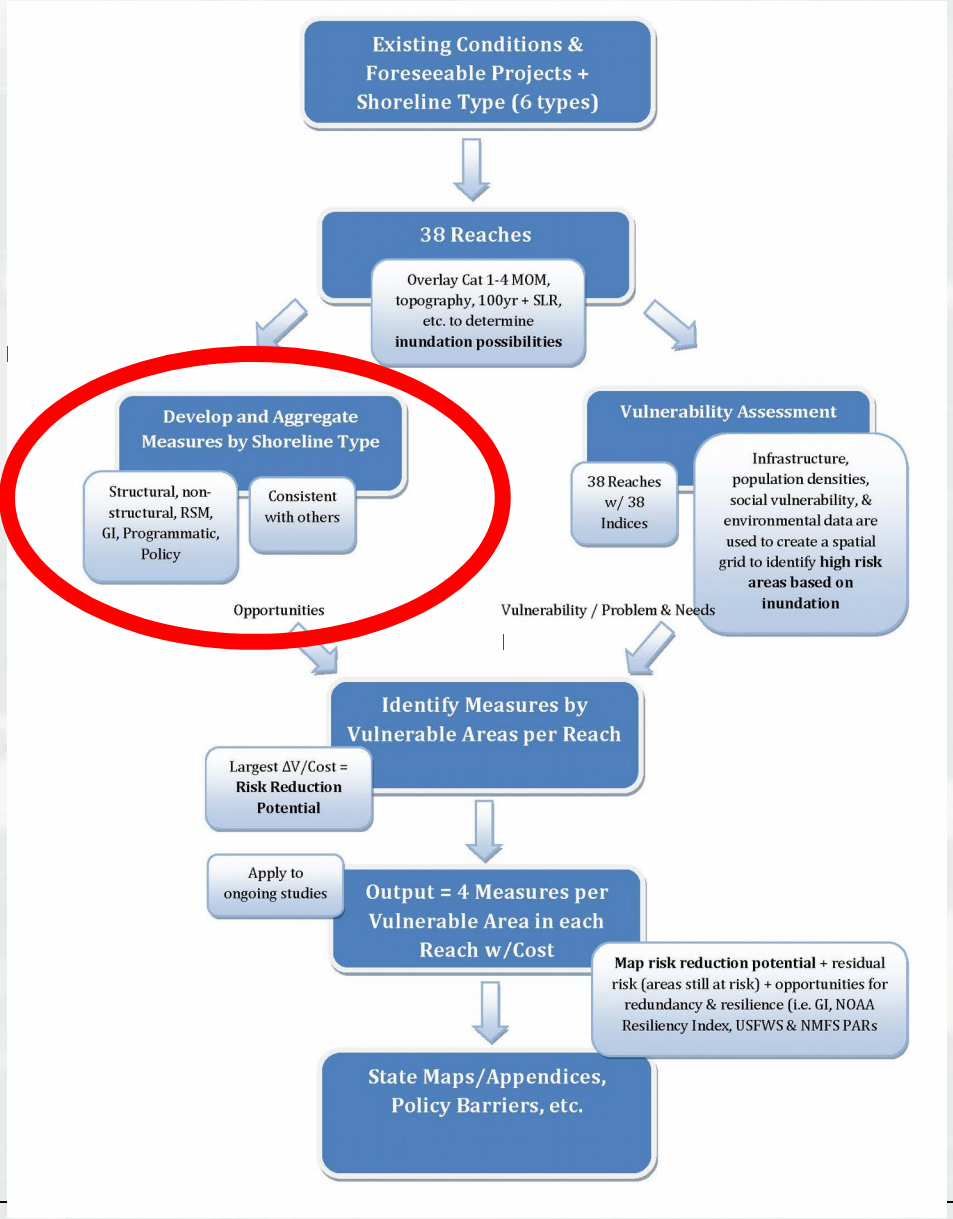
Plan Formulation and GIS Process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Plan Formulation and GIS Process

- Develop comprehensive measures list
  - Structural – sacrificial
  - Structural – non-sacrificial
  - Structural – green infrastructure
  - Upland Storage/Stormwater Management (includes green infrastructure)
  - Floodplain Restoration/Storage
  - Non-structural
  - Policy/Programmatic
- Assess appropriateness of measures by shoreline type (i.e., bluff, sandy, back bay, barrier island, etc.)

Risk Reduction and Resilience Measures

Measure	Definition	Effect	Examples
Natural	Created through the action of physical, biological, geologic, and chemical processes operating in nature	Shoreline erosion control, wave and surge attenuation, especially in low-energy environments; additional resilience benefits; dynamic behavior and response affect performance with respect to objectives	Barrier islands, dunes, reefs, wetlands, marsh islands and riparian corridors
Nature-Based	Products of planning, engineering design, and construction incorporating natural processes that contribute to coastal risk reduction and resilience	Shoreline erosion control, wave and surge attenuation, especially in low-energy environments; dynamic behavior and response affect performance with respect to objectives	
Non-Structural	Products of public policy, management and regulatory practices; may include pricing schemes, planning, engineering design, and construction	Modify or avoid the impacts of the hazard (vs. modifying the hazard); relatively predictable level of performance with respect to objectives	Structure acquisitions or r proofing, implementing flo flood preparedness planni land use regulations, development restrictions greatest flood hazard areas, ele dev retreat, evacuation, buyout and leaseback

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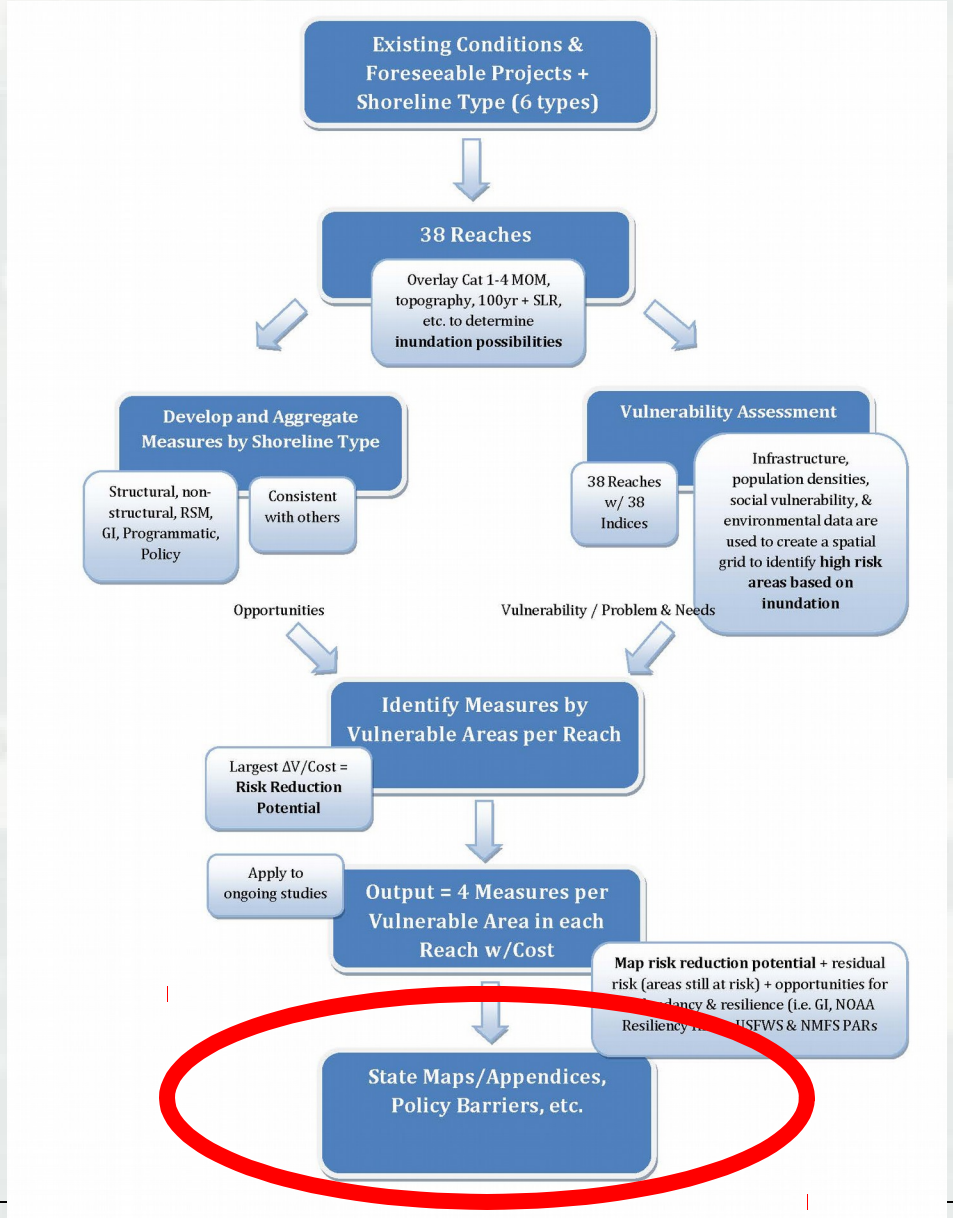
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